Stephen D. Wolters

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Post-Doctoral Career

Caltech Postdoctoral Scholar, (08/2011-)

- Role of Comet and Asteroid Observer at the NASA Jet Propulsion Laboratory
  - Experienced observer using optical CCD photometry and near/mid-IR spectrometry;
  - Co-I of ESO Large Programme on "Direct Detections of the Asteroidal YORP effect" which is the largest programme ever accepted at ESO in open competition;
    - Programme is split into optical and thermal components: I have been undertaking the thermal IR programme awarded 103 hours of category A time on VLT/VISIR
    - Developed software tools using Python to develop an efficient procedure to reduce VLT/VISIR thermal IR photometry rapidly and accurately and to derive physical properties using thermal models and Monte Carlo trials;
  - NASA-IRTF SpeX near-IR observations of unbound asteroid pairs, investigating space weathering on fresh asteroid surfaces
  - Palomar and Table Mountain observations of YORP-detection candidates and unbound asteroid pairs
  - thermal modelling of comet-asteroid transition candidates using NEOWISE data

Planetary and Space Sciences Research Institute (PSSRI) at the Open University (05/2006-08/2011)

- *Solar System Observing (09/2009-08/2011)*:
  - SuperWASP exoplanet survey to obtain serendipitous observations of asteroids:
    - 1000s of asteroids observed optically over several years from 2007;
    - Used complex software tools to remove "blending" from background stars and account for a thermal offset in the camera network by using a database of standard stars;
    - Pieced together optical phase curves and Kaasalainen shape models: 307 asteroids observed, with 486 lightcurves produced.
  - PhD supervisor for three students (all completed).

- *Project manager of WatSen (06/2007-04/2010):* an ESA contract to develop a water sensor for a future Mars/asteroid/lunar mission.
  - WatSen is a compact breadboard prototype ATR spectrometer, microscope and humidity sensor, with the OU as prime contractors;
  - Coordinated with international industrial partners to deliver instrument under budget (approx. $400 000);
  - For two years running was awarded merit award from the Science Faculty for outstanding contribution to the WatSen project;
  - Ran testing programme in Martian analogue environment;
  - Wrote 140 page technical report and delivered instrument to ESA;
  - Organised Progress Meetings and gave several presentations to ESA;
  - Written Payload Definition documents for MarsNEXT and Marco Polo, a proposed Near Earth Asteroid (NEA) sample return mission;

- *Sub-contracted payload engineer for QinetiQ (pre post-doc 05/2006-06/2007):* Defined the science payload for an ESA Phase A study on Don Quijote, a proposed impact mitigation preparation mission to an NEA.
  - Assessed the physical properties of the target NEAs;
  - Defined scientific measurement requirements, prioritised and sized payload (e.g. optical, near and mid-infrared, X-ray, laser altimeters, radio science);
  - Modelled thermal properties of target NEAs to assess measurement of Yarkovsky effect;
  - Wrote 150 page technical report which was reviewed by NEOMAP (Near-Earth Object Mission Advisory Panel, set-up by ESA and consisting of 6 world-leading scientists)

- Established a network with space experts from diverse disciplines;
- I have given presentations at 5 progress meetings and at the Final Presentation with ESA.

- *Associate Lecturer for the Open University*:
  - Teaching course S282 Astronomy to students from a wide range of backgrounds
  - On course team for OU course "Science in Context", developing new teaching material
  - Tutor on Open University Residential School SXR208: Observing the Universe, teaching practical astronomy to OU students using telescopes in Majorca
  - Series of public outreach lectures to schools and astronomy societies across the country about Near-Earth asteroids and the impact hazard (9 in two years)

Education and Post-Graduate Research

Ph.D. from PSSRI, supervised by Dr. Simon Green, defended Nov. 2005, awarded 28 Feb. 2007.
Thesis: Thermal Infrared and Optical Observations of Near-Earth Asteroids (NEAs).

- On four observing runs (UKIRT on Mauna Kea using Michelle spectrometer and UIST, JKT in La Palma), learnt how to acquire complex technical skills quickly and work under pressure.
- Some important results:
  - increased number of NEAs with measured diameters by 10%
  - developed a new thermal model, simulating emission from the night side of an asteroid, and significantly improving accuracy of old standard model
- Self-motivated to manage a complex research project over several years. Astronomical observations reduction and analysis experience:
  - Used CCD photometry software to reduce optical photometry, deriving composite lightcurves of NEAs with Fourier analysis
  - Wrote programs to fit thermal models to the IR spectra to determine NEA albedos and diameters
- Attended several conferences, becoming proficient at creating concise presentations:
  - One of 20 students across Europe sponsored by the European Space Agency (ESA) to give an oral presentation at the Committee on Space Research (COSPAR) in Paris, June 2004

Degree: M.Sci. Physics with Space Science at University College London (1997-2001, Class: 2:1)

- 4th year project: investigating magnetic reconnection in solar flares at the Mullard Space Science Laboratory (MSSL)
- 2nd year project developing code for the Refraction Grating Spectrometer (RGS) on the X-ray Maximum Mission (XMM) at MSSL.

Secondary and sixth form school: Winchester College
A-Level: Physics (A), Mathematics (A), Biology (A)

Additional Skills

- Project management workshop formalised skills acquired from several years project management of WatSen
- Part of Astrium team for entry into Planetary Society's Apophis Mission Design competition, consulted on science and payload
- Refereed several papers for peer-reviewed journals, and reviewed standard grant applications for funding council
- Programming: IRAF, Java, C++, IDL, Fortran90; familiar with Windows, MacOSX and UNIX
- Creative writing course, 2003, very useful techniques for writing in a lively manner
- Clean UK driving licence

Professional membership

Royal Astronomical Society; American Astronomical Society; American Geophysical Union

Interests

I am a trustee in a charity called ICMK: a project to develop an independent cinema for the city of Milton Keynes, and I programme the film seasons for the associated touring cinema. I like to read and

write science fiction for fun. I have been involved in a virtual learning environment outreach project teaching primary school children.

Collaborations

Direct Detections of the Asteroidal YORP Effect ESO Large Programme: PI S. C. Lowry (University of Kent, UK). Collaborating institutes: Queen's University Belfast (UK), The Open University (UK), Jet Propulsion Laboratory (US). *Role: Running thermal IR component.*

SuperWASP: Wide Angle Search for Planets: PI D.L. Pollacco (Queen's University Belfast,UK). Collaborating Institutes: Instituto de Astrofisica de Canarias, Isaac Newton Group, Keele Univ. (UK), Leicester Univ. (UK), The Open University (UK), St. Andrews Univ. (UK). *Role: Asteroid photometry.*

Marco Polo: Near-Earth asteroid sample return mission (proposed ESA Cosmic vision mission: http://www.oca.eu/michel/SRE-2009-3_Marco-Polo21.pdf). PI: M. A. Barucci (LESIA-Paris Observatory). Collaborating institutes: MPS (Germany), INAF (Italy), Open University (UK), Space Exploration Institute (Switzerland), Univ. Nice (France), Univ. Helsinki (Finland), DLR Berlin (Germany), ESA, MIT (US), JAXA (Japan). *Role: Payload definition for lander instrument based on WatSen.*

Submitted Papers

Wolters, S. D., J. K. Hagene, A. T. Sund, A. Bohman, W. Guthery, B. T. Sund, A Hagermann, T. Tomkinson, J. Romstedt, G. H. Morgan, M. M. Grady. WatSen: a prototype mid-IR spectrometer and microscope package for Mars exploration. Submitted to Experimental Astronomy

Published Papers

Duddy, S.R., S. C. Lowry, A Christou, **S. D. Wolters**, B. Rozitis, S. F. Green P. R. Weissman (2012). Spectroscopic observations of unbound asteroid pairs using the WHT. Accepted in Monthly Notices of the Royal Astronomical Society, DOI: 10.1093/mnras/sts309.

Duddy S.R., Lowry S.C., **Wolters S.D.,** Christou A., Weissman P., Green S.F., Rozitis B. (2012). Physical and Dynamical Characterisation of the Unbound Asteroid Pair 7343-154634. Astronomy & Astrophysics, 539, A36.

Wolters, S. D,, B. Rozitis, S. R. Duddy, S. C. Lowry, S. F. Green, C. Snodgrass, O. R. Hainaut, P. Weissman (2011). Physical Characterisation of low delta-V asteroid (175706) 1996 FG3, Monthly Notices of the Royal Astronomical Society, 418, p1246-1257.

Wolters, S. D., A. J. Ball, N. Wells, C. Saunders and N. McBride (2011). "Measurement Requirements for a near-Earth Asteroid Mitigation Demonstration Mission", Planetary and Space Science, 59, 1506.

Wolters, S.D., Green, S.F. (2009) "Investigation of Systematic Bias in Radiometric Diameter Determination of Near-Earth Asteroids: the Night Emission Simulated Thermal Model (NESTM)" Monthly Notices of the Royal Astronomical Society, 400, pp. 204-218, DOI: 10.1111/j.1365-2966.2009.14996.x.

Ball, A. J., S. Ulamec, B. Dachwald, M. E. Price, R. Nadalini, B. Luethi, **S. D. Wolters** et al. (2009). A Small Mission for In Situ Exploration of a Primitive Binary Near-Earth Asteroid. Advances in Space Research 43, pp. 317-324, DOI information: 10.1016/j.asr.2008.04.015.

Wolters, S. D., S. F. Green, N. McBride and J.K. Davies (2008). "Thermal infrared and optical observations of four near-Earth asteroids." Icarus 193(2): 535-552.

Tomkinson, T, Wade, J., Busemann, H., Franchi, I., Hagermann, A., Wright, I., **Wolters, S.** and Grady, M. (2008). Studying the oxygen and carbon isotope characteristics of carbonate analogues to ALH 84001. Meteoritics and Planetary Science, 43, A155

Davies, J. K., A. W. Harris, A. S. Rivkin, **S. D. Wolters** et al. (2007). "Near-infrared spectra of 12 Near-Earth Objects." Icarus 186(1): 111-125.

Wolters, S. D., S. F. Green, N. McBride and J.K. Davies (2005). "Optical and thermal infrared observations of six near-Earth asteroids in 2002." Icarus 175: 92-110.

Powell, C. R., A. J. Norton, C. A. Haswell, **S. D. Wolters** et al. (2002). "Identification of the optical counterpart of 1RXS J190141.0+012618 and a search for the optical counterpart of XTE J1901+014." The Astronomer's Telegram 93: 1.

Technical Reports

Wolters, S. D., , A. Bohman. J. K. Hagene, A. Tore Sund, B. Tore Sund, M. Grady (June, 2010) WatSen: A combined IR spectrometer, Microscope and Humidity Sensor Summary Report (WS-OU-PS-ExecSum), European Space Agency, pp26.

Wolters, S. D., W Guthery, A. Bohman, J. K. Hagene, M. Grady (May 2010) WatSen: Test Report and Critical Performance Assessment (TN10), European Space Agency, pp144.

Wolters, S. D., A. J. Ball, and N. McBride (2007). Don Quijote Phase A Study ENG02: Model Payload, ESA**:** pp 148 (http://esa-mm.esa.int/docs/NEO/QinetiqDQExecSum.pdf).

D'Arrigo, P., E. Allouis, S. Barraclough, A. Carusi, V. Dehant, O. Karatekin, S. Kemble, M. Paetzold, R. Parkinson, M-C. Perkins, E. Perozzi, A. Povoleri, X. Semberly, C. Trenkel, M. Watt, **S. D. Wolters** (2007). APEX: Apophis Explorer (Proposal for the Apophis Mission Design Competition, EADS-Astrium**:** pp 39 (http://www.planetary.org/programs/projects/apophis_competition/winners.html).

Selected Conference Abstracts

S. D. Wolters, P Weissman, S R Duddy, A Christou, S F Green S C Lowry, B Rozitis. Near-IR Spectroscopy and Visual Broadband Photometry of Unbound Asteroid Pairs. Division of Planetary Sciences Meeting, October 2012, Reno, NV

S. D. Wolters, S. C. Lowry, S. R. Duddy, A. Fitzsimmons, S. F. Green, M. Hicks, E. D. Rosenberg, B. Rozitis, C. Snodgrass, P. R. Weissman. (2012). Physical Characterisation of Fast-Rotating Near-Earth Asteroids. Asteroids, Comets, Meteors 2012, TOKI Messe (Niigata Convention Center) 16-20 May 2012, Niigata, Japan

Rozitis B., Green S. F., Duddy S. R. Fitzsimmons A., Hicks M., Lowry S. C., Snodgrass C., Weissman P. R., **Wolters S. D.** The Influence of Global-Selfheating on the Yarkovsky and YORP Effects. Asteroids, Comets, Meteors 2012, TOKI Messe (Niigata Convention Center) 16-20 May 2012, Niigata, Japan

Duddy, S.R., S.C. Lowry, **S.D. Wolters**, B. Rozitis, S.F. Green, A. Christou, and P. Weissman. (2012). Spectroscopic Analysis of Unbound Asteroid Pairs. Joint meeting of the UK and German National Astronomy Meetings, University of Manchester 20-30 March, Manchester, UK.

Duddy S.R., Lowry S.C., **Wolters S.D.**, Rozitis B., Green S.F., Christou A., Weissman P. (2011). Spectroscopic Observations of Unbound Asteroid Pairs. Division of Planetary Sciences Meeting, October 2011, Nantes, France

Wolters, S. D. and S. F. Green (2008). The Night Emission Simulated Thermal Model for Near Earth Asteroids. Thermal Modelling of Planetary Surfaces in the Solar System (THERMOPS) Workshop, Nice, France.

Wolters, S. D. and S. F. Green (2008). The Night Emission Simulated Thermal Model for Near Earth Asteroids. Asteroids, Comets and Meteors (ACM 2008), Baltimore, Maryland, USA.

Wolters, S. D., A. J. Ball and N. McBride (2008). Science Investigations and Payload for the Don Quijote Mission – Results of the Phase A Study. Asteroids, Comets and Meteors (ACM) 2008, Baltimore, Maryland, USA.

Tomkinson, T., **S. D. Wolters**, et al. (2008). WatSen - A Miniaturized Package to Detect Water on Mars. 39th Lunar and Planetary Science Conference, p 2040.

Skidmore, M. S., R. M. Ambrosi, N. Nelms, A. J. Ball, **S. D. Wolters** et al. (2007). A Hybrid X-Gamma Detector for In-Situ Planetary Science. UK Planetary Forum: Early Career Researchers' Planetary Meeting. Trinity College, Oxford.

Wolters, S. D., S. F. Green, N. McBride and J.K. Davies (2004). Thermal Infrared and optical observations of near-Earth asteroids at high phase angle. 35th COSPAR Scientific Assembly. Paris**.**

Wolters S. D., S. F. Green, N. McBride, J. K. Davies (2004). Thermal infrared and optical observations of near-Earth asteroids, The Royal Astronomical Society National Astronomy Meeting, Milton Keynes.

Wolters S. D. (2003). Optical and thermal infrared observations of near-Earth asteroids, Young Person's Planetary Meeting.